

GE  
Transportation

Approaching the  
next regulatory  
level



Los Angeles  
Convention Center  
February 26, 2008

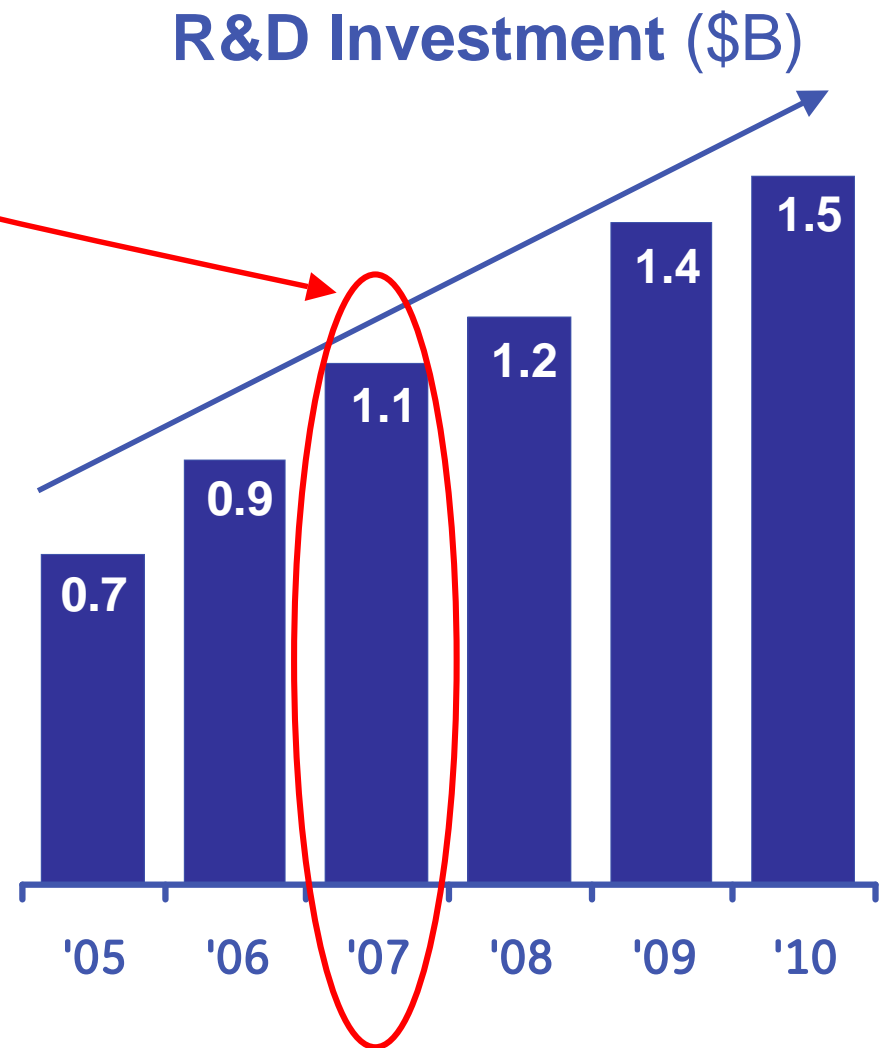
# ecomagination<sup>SM</sup>

We continue to take a new approach to solving our customers' toughest environmental challenges



# ecomagination<sup>SM</sup>

- **Double R&D**
- **Reduce GHG emissions from operations**
- **Keep public informed**
- **Make customers true partners**
- **Grow revenues**



# Addressing emissions on all fronts

*Hybrid*



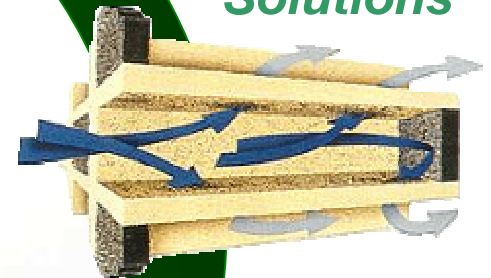
*Leveraging  
the growth  
platform*



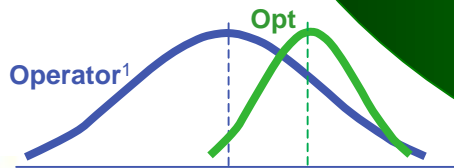
*Beyond  
Diesel*



*After  
treatment  
Solutions*



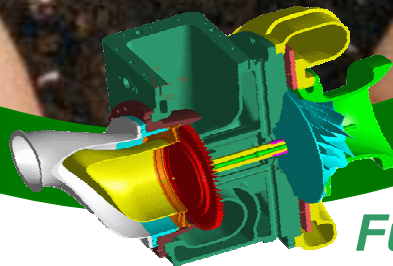
*System  
Efficiency*



*Beyond  
Mainline*



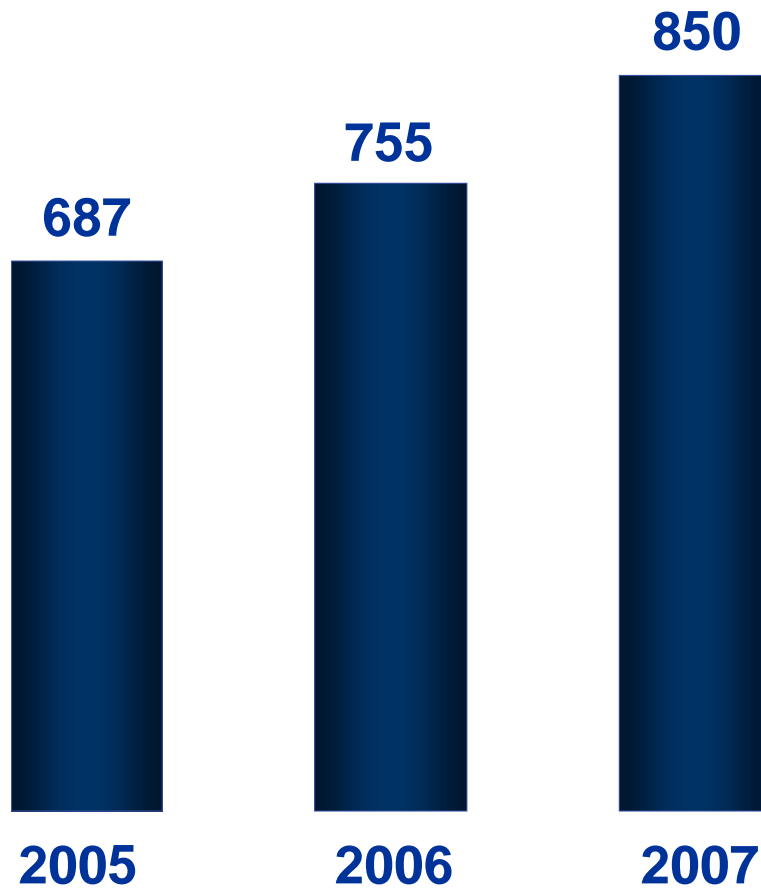
*Fuel Efficiency*



imagination at work

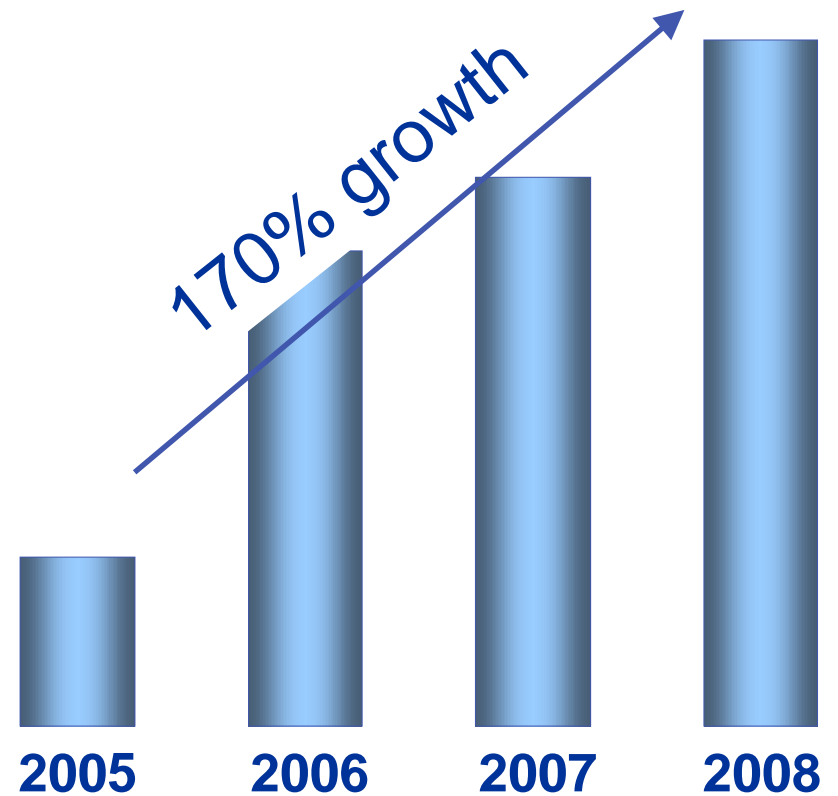
# Evolution adoption

## Evolution production



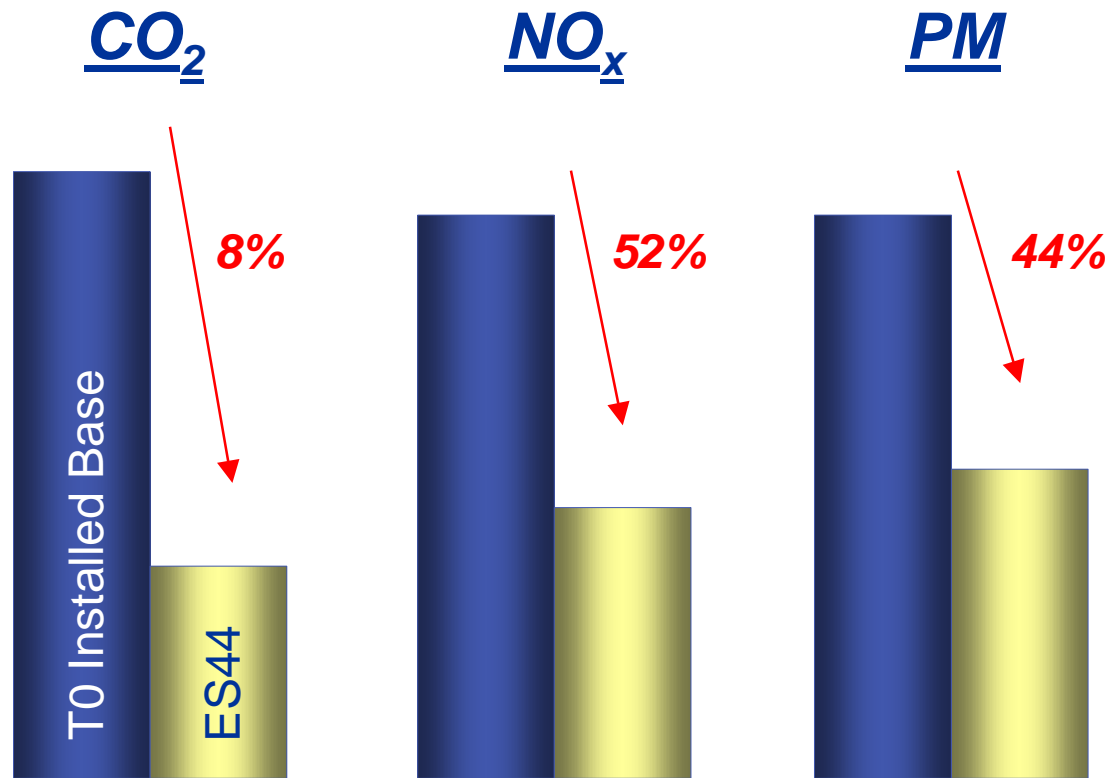
**Nearly 2,300 units in service**

## Evolution backlog



**Backlog over 2,500 units**

# Emissions benefit



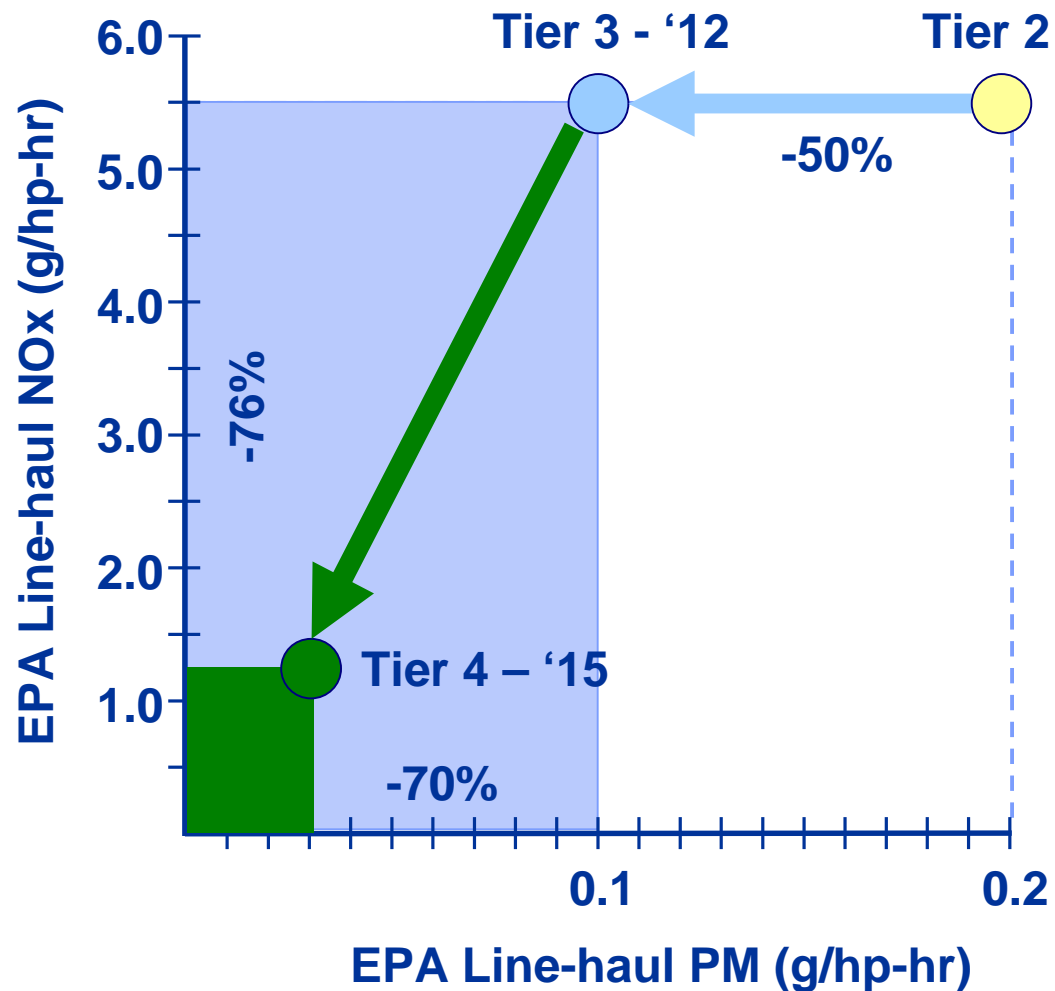
Tons/yr reduced with Evolution replacement

With current Evolution installed base

- >680k tons/yr CO<sub>2</sub>
- >90k tons/yr NO<sub>x</sub>
- >1.5k tons/yr PM

- Aggressive adoption yields accelerated emissions benefits
- Enhanced value drives aggressive adoption
- What delivers value to the railroad
  - Improved fuel efficiency
  - Reduced maintenance
  - Reduced overhaul cost
  - Increased performance
  - Improved reliability
- Railroad performance & improved emissions go hand in hand

# Evolution . . . platform to next tiers

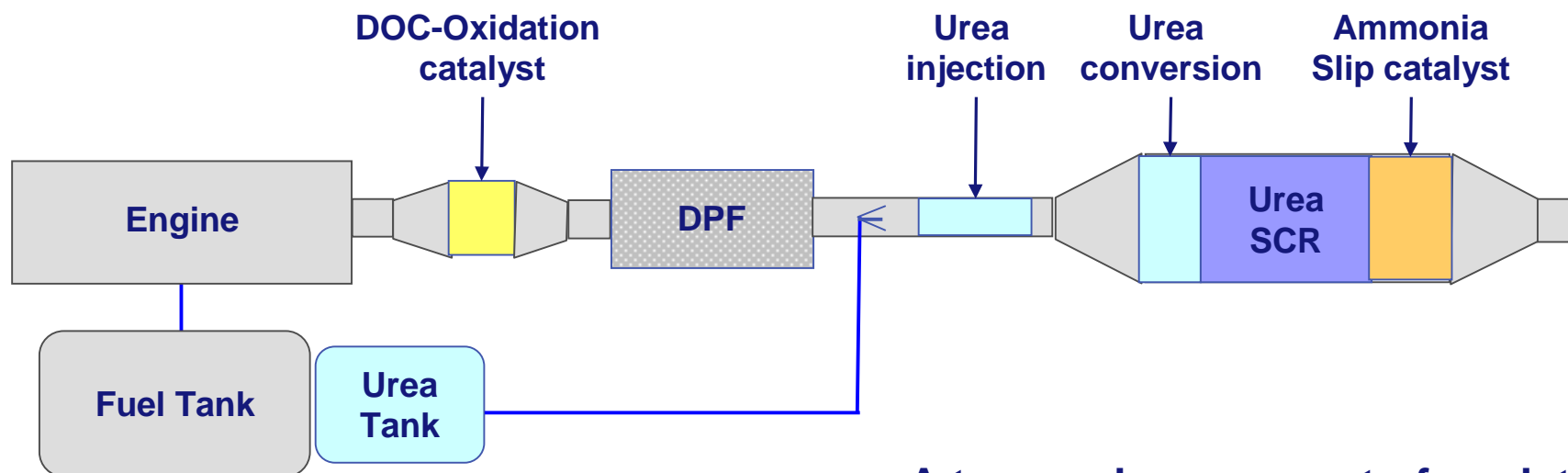


## Tier Technology

- 3
  - Fuel system improvement
  - Combustion optimization
  - Turbo optimization
  - Ultra low sulfur diesel
- 4
  - All Tier 3 technology
  - Diesel particulate filter (DPF)
  - NOx aftertreatment (Urea SCR)
  - Ultra low sulfur diesel

# Next tier . . . technology forcing

## Aftertreatment – Urea SCR (*Selective Catalytic Reduction*)



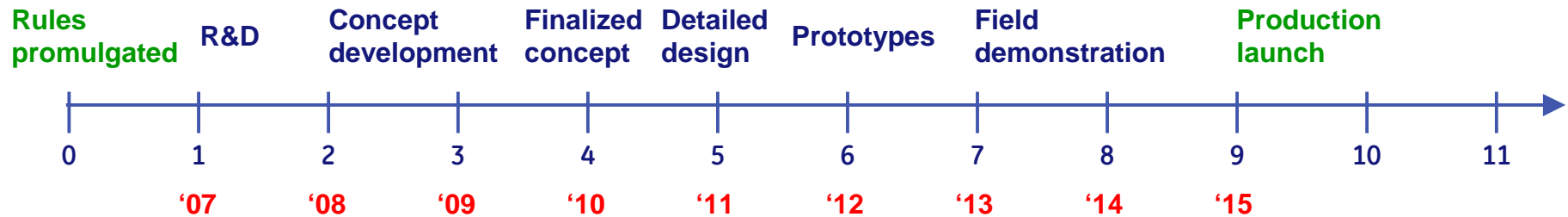
### Urea SCR . . . Providing a solid start

- Very good NO<sub>x</sub> control
- Technology further advanced
- On highway aftertreatment choice

### A tremendous amount of work to go

- Temperature
- Catalyst size
- Dosing accuracy & distribution
- Thermal Aging / Poisoning
- Ammonia slip
- Back pressure & fuel impact
- Physical constraints

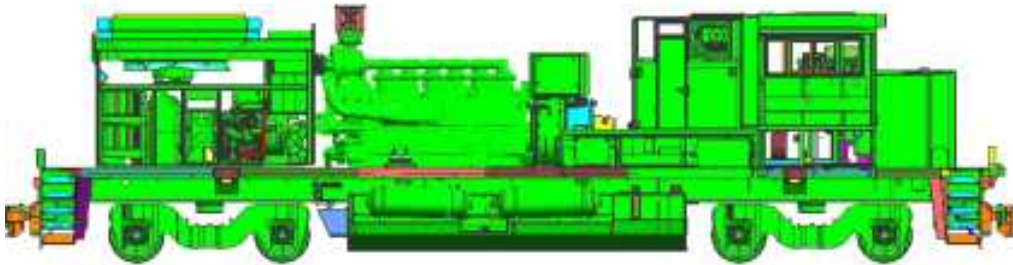
# Development timeline



- Aggressive nine (9) year development schedule
- Based on successful Evolution launch . . . Eight years without significant R&D
- R&D started well ahead of rule making
- Promulgation behind schedule
- Research, Product engineering, Manufacturing & Supply chain fully engaged
- Already significant schedule pressure

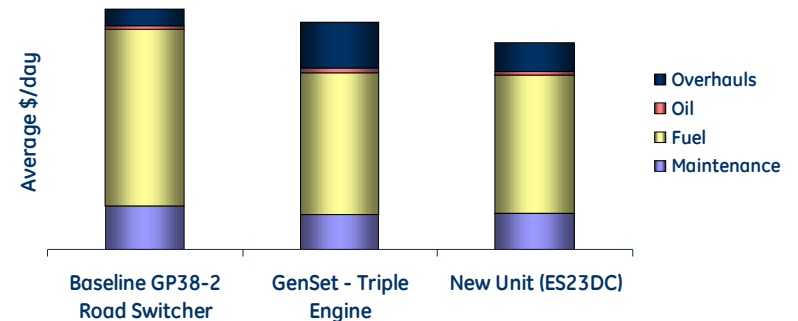
# Beyond mainline

## Regional & Switcher applications

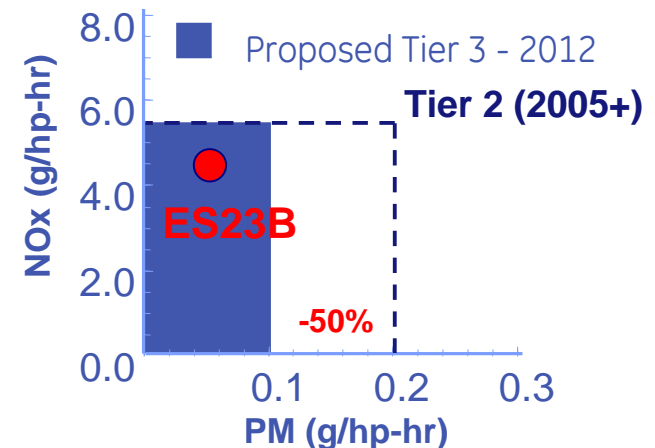


- New GEVO I6 - 2,300 HP. . . Inline 6 cyl engine based on proven Evolution GEVO-12
- Standardized control system with Evolution main line family
- Enhanced cooling system to enable fuel and emissions performance
- Extensive option list including RCL, dynamic brake, electronic air brake
- New or modernization versions

## Lower Life Cycle Costs



## Tier 3 emissions

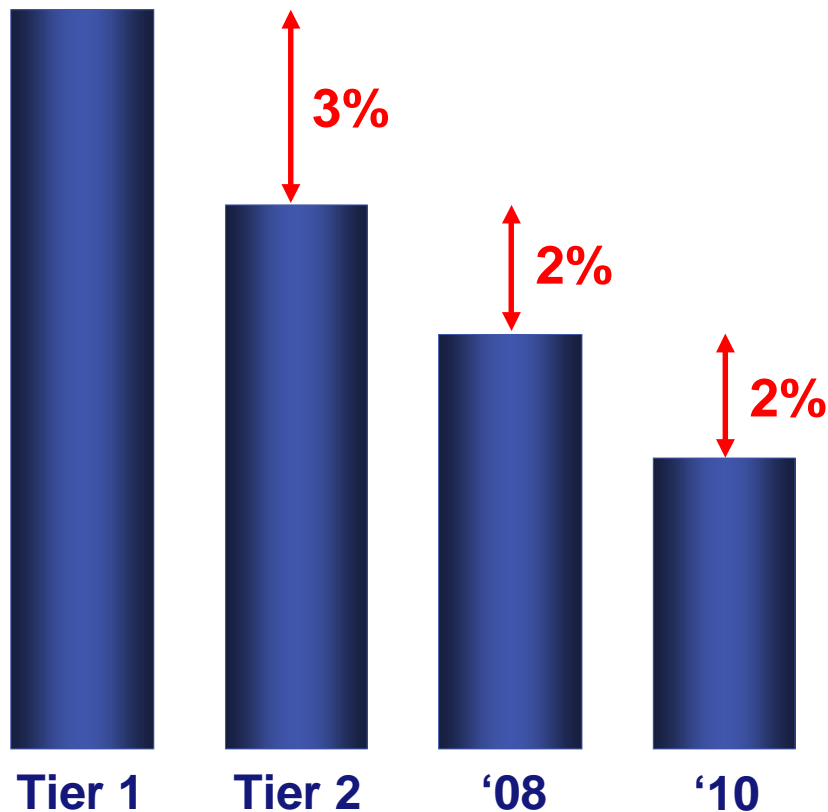


## Service consistency

- Common maintenance, tooling & systems with main line

# Fuel efficiency focus

## Fuel performance



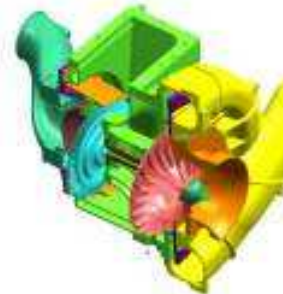
**Further reductions required to offset pressure from regulations**



## Reducing fuel consumption

- Attacking all areas of opportunity

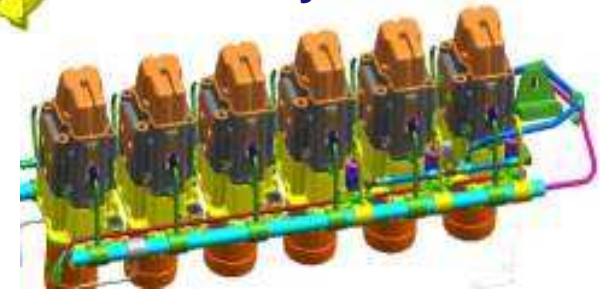
### Turbocharger



### Piston



### Fuel system



- Multigenerational plan for ongoing improvements → leverage Evolution Series<sup>®</sup> growth platform

**Fuel improvement drives emissions & GHG improvement**

# System solutions

## Trip Optimizer . . . Beyond traditional approach

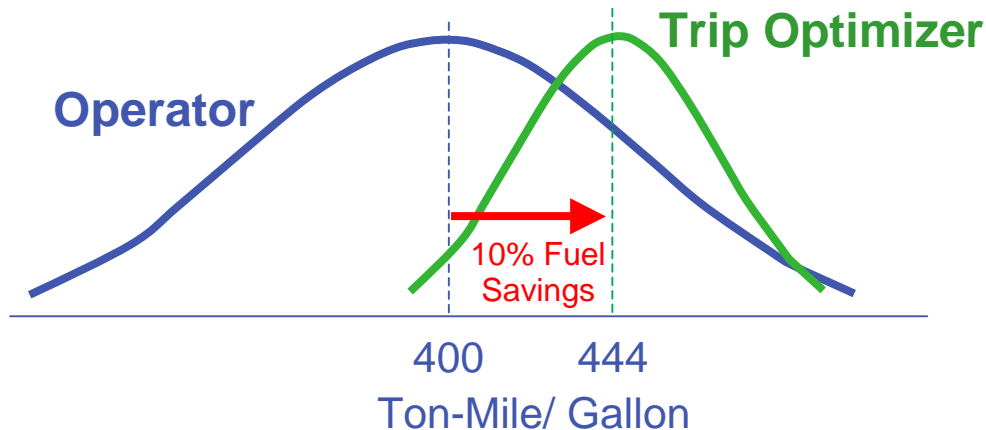
### Train and driver variations result in:

- Less than optimal fuel use
- Higher emissions



### Trip Optimizer:

1. Evaluates entire route for fuel savings opportunities & plans optimal route
2. Controls the throttle to the plan



- Fuel savings . . . 10%+
- Emissions savings . . . 10%+
- Consistent operations
- Reduced wear & tear
- Migration to higher automation

## Filed demonstrations validating savings

# Beyond diesel

GE fuels focus  
Over \$100MM investment

GE Energy



GE GRC



GE Aviation



GE Transportation



## Biodiesel Issues



- Crankcase dilution – leads to oxidation
- Microbial growth – storage and cleanliness
- Cold weather stability – gums up systems

## GE testing

**Single cylinder  
Stationary engine  
Locomotive**

Purpose  
Performance  
Durability  
Operability

Status  
✓ B2-B20, S500-S15  
Ongoing  
Planning

## Delivering fuel flexibility



- Locomotive Fuel Flex option
- Ensures compliant & consistent performance
- Real time optimization of burn based on fuel in tank

# Evolution Series<sup>®</sup> Hybrid

The Evolution Hybrid stores power utilized from dynamic braking to supplement the diesel-electric engine, thereby reducing emissions & fuel consumption



# Roll out

## Evolution Series<sup>®</sup> Hybrid Loco Demonstrator

GE ecomagination launch

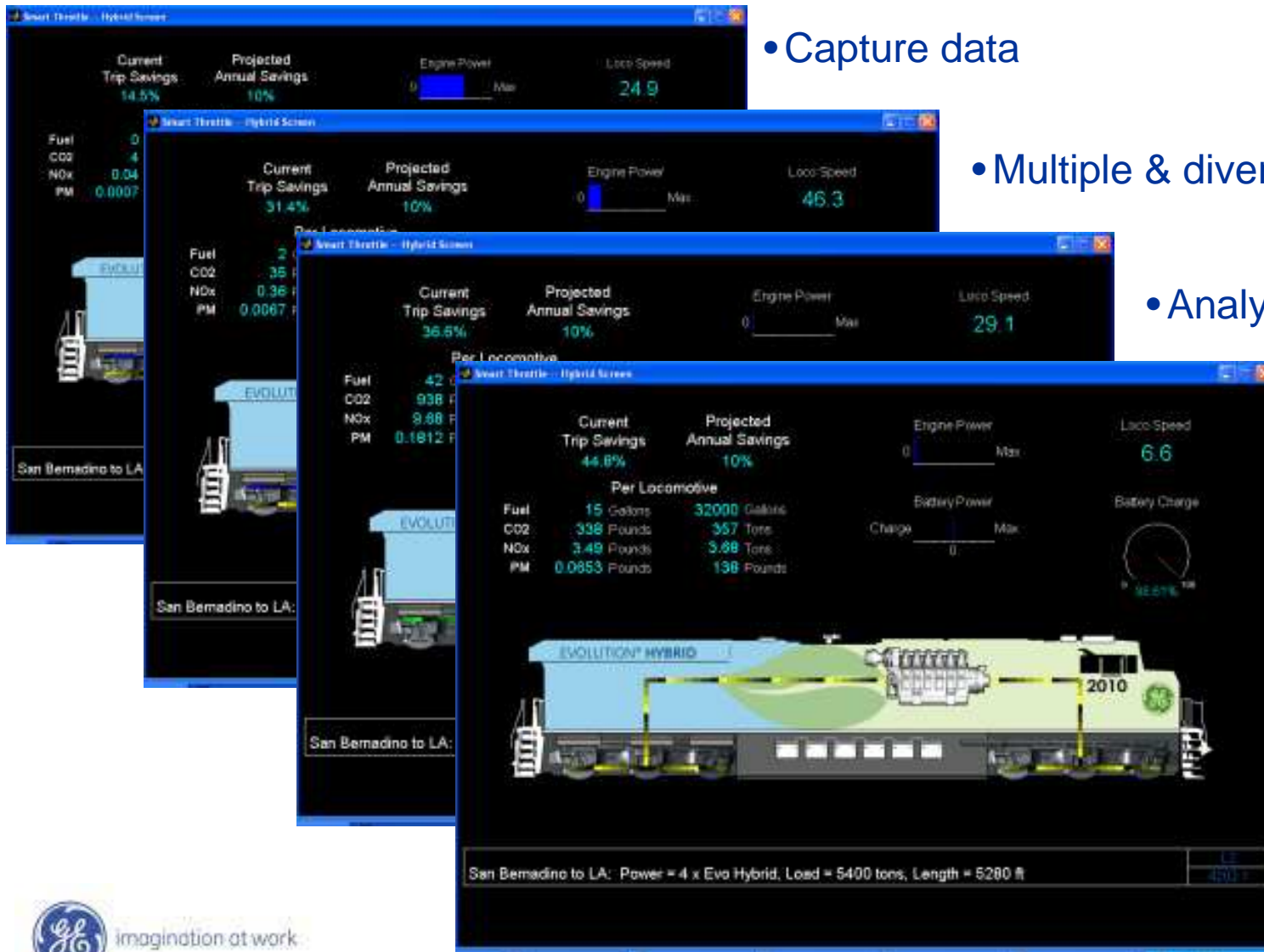
Los Angeles Union Station - May 24, 2007



- ✓ Proof of concept
- ✓ Configuration validation
- ✓ Battery packaging
- ✓ Test track & field test bed

# Moving from the lab to the field

## Experience in the real world



- Capture data

- Multiple & diverse applications

- Analyze performance

- Refine perf. Model

- Reliability validation

- Operational impact

- Service impact

# Next steps

- 2<sup>nd</sup> generation prototype locomotive
- Field validation
- Battery optimization



# Emissions reductions . . .



. . . it certainly is not easy,  
but GE is thrilled to be part of the team  
& in the game



imagination at work